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THE IMPACT OF DIGITAL TRANSFORMATION ON REGIONAL LABOUR MARKETS IN GERMANY: SUBSTITUTION POTENTIALS OF OCCUPATIONAL TASKS

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ABSTRACT

The digital transformation may have large impact on the labour market. In order to determine the extent to which occupational tasks are currently replaceable by computers or computer-controlled machines, Dengler and Matthes (2015b, 2018b, 2018a) calculated substitution potentials of occupations. In this paper, we investigate the impact of digital transformation on different regions in Germany by analysing substitution potentials of occupational tasks on two different regional levels: administrative districts and regional labour markets.

On the level of districts, it becomes clear that urban service centres and some rural areas have a much lower share of employees working in a highly substitutable occupation compared with manufacturing regions. In many cases, low and high values cancel each other out within regional labour markets. Nevertheless, the values still range from 15 to 38 percent. In high value regions, close monitoring of future labour market developments and (further) education appear to be of particular importance to meet the challenges of the digital transformation.

KEYWORDS

Digital transformation; Occupational tasks; Regional Labour markets; Germany

1 INTRODUCTION

The impact of digital transformation on the labour market is currently being discussed in many public and scientific debates. There are fears that the ongoing digital transformation may substitute jobs. In fact, there are more and more areas of work in which computers or computer-controlled machines perform tasks that could previously only be done by humans. However, the impact of digital transformation on employment is controversial. On the one hand, machines can take over more and more tasks and thus lead to job losses (Keynes, 1933). On the other hand, new technologies also create new opportunities. Occupations may be freed from monotonous tasks and could become more interesting and productive, and therefore eventually better paid. Additional jobs may be created as the new products and services have to be built and provided. In addition, new jobs can also be created through productivity gains, as prices fall and demand increases (Appelbaum and Schettkat, 1995). Previous empirical studies also come to controversial conclusions. For example, Acemoglu and Restrepo (2017) investigate the effects of industrial robots between 1990 and 2007 in the USA and find a decline in employment. Dauth et al. (2017), on the other hand, find no negative effects of industrial robots on total employment in Germany.

Another branch of literature deals with automation probabilities of occupations. The prominent study by Frey and Osborne (2017) suggests that approximately 47% of jobs in the USA will be replaced by computers or computer-controlled machines in the next 10 to 20 years. This study uses assessments by technology experts on future automation probabilities of occupations. As technology experts may overestimate the technical possibilities, the automation probabilities may be exaggerated (Dengler and Matthes, 2018a). If the results of Frey and Osborne (2017) are transferred to Germany, similarly high values are obtained (Bonin et al., 2015; Brzeski and Burk, 2015; Arntz et al., 2016).

What these studies have in common is that they assess entire occupations by their automation probabilities. Studies that consider tasks within occupations show that only 9% of US employees and 12% of German employees are at risk of automation in the next 10 to 20 years (Bonin et al., 2015; Arntz et al., 2016, 2017). Nevertheless, these studies also use the automation probabilities of Frey and Osborne (2017).

In order to avoid all these problems, Dengler and Matthes (2015b, 2018b, 2018a) calculate automation probabilities, so-called substitution potentials of occupations, directly for Germany on the basis of the expert database BERUFENET of the Federal Employment Agency. The BERUFENET contains occupational information for all known occupations in Germany, such as occupations. Dengler and Matthes (2015b, 2018b, 2018a) then determine the substitution potential for each of the approximately 4,000 occupations in Germany by determining the proportion of tasks that could already be taken over by computers or computer-controlled machines today on the basis of the task-based approach of Autor et al. (2003). The decision of whether a task is substitutable corresponds to the distinction between routine tasks and non-routine tasks in the task-based approach (Dengler et al., 2014). The term ‘routine’ means that an activity can be broken down into machine-programmable sub-elements and can be replaced by machines. Three coders independently researched whether each of the approximately 8,000 tasks could be performed by computer-controlled machines or computer algorithms automatically. This assessment is all about the current technical feasibility and does not consider future substitution potentials. Whether these tasks are actually taken over by computers will also depend on other factors such as legal and ethical obstacles, cost considerations and preferences. For example, if human work is more economical, more flexible or of better quality, or if legal or ethical obstacles prevent automation, there will be no substitution (Dengler and Matthes, 2018a).

Thus, the substitution potentials measure the extent to which occupational tasks are currently replaceable by computers or computer-controlled machines. The substitution potentials were first calculated for the year 2013 (Dengler and Matthes, 2015b, 2018a). However, as the digital transformation progresses, Dengler and Matthes (2018b) updated the substitution potentials for the technological possibilities in 2016. Between 2013 and 2016, many new technologies have become market-ready. These include in particular mobile, collaborative robots and machine learning as well as the first applications of 3D printing and virtual reality. For example, insurance applications can be checked fully automatically or prostheses and dental prostheses can be manufactured using 3D printing. At the same time, however, occupational profiles have also changed in recent years: tasks in some occupations have changed and new tasks or occupations have emerged.

In this paper, we analyse substitution potentials of occupational tasks on regional labour markets in Germany for the year 2016. We focus on occupations in which more than 70 percent of the tasks are replaceable by computers or computer-controlled machines. The share of employees working in such occupations has risen from approximately 15 to 25 percent between 2013 and 2016 (Dengler and Matthes, 2018b). However, the authors do not expect the same number of jobs to be lost. On the contrary, they assume that occupations and tasks will change.

2 VARIATION BY DISTRICTS

Depending on the regional occupational structure, regions differ considerably with regard to the share of employees working in occupations in which more than 70 percent of the tasks are replaceable by computers or computer-controlled machines (Dengler et al., 2018). Figure 1 shows that the values range from 14.3 percent in Vorpommern-Rügen to 51 percent in Dingolfing-Landau. In order to reflect how districts are

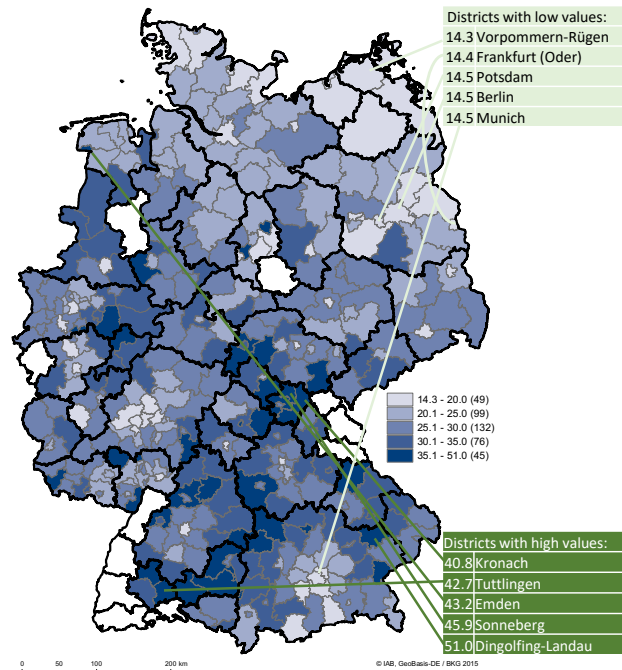


Figure 1: Share of employees working in occupations with high substitution potential by districts

Source: Dengler and Matthes (2018b), Statistics of the Federal Employment Agency (30 June 2017), Berufenet (2016), Kropp and Schwengler (2016).

connected by commuting employees, the borders of regional labour markets (Kropp and Schwengler, 2016) are drawn in the map. We will discuss them in the next section.

In addition to some rural districts – especially in the north and northeast of Germany – urban districts show low values. A notable exception is the city of Emden, where the port and a large VW plant employ many people in manufacturing and logistics. Overall, a pattern emerges that is the result of the economic specialisation of regions (Buch et al., 2016; Dengler et al., 2018). In particular, where the manufacturing industry is strongly represented, many employees work in manufacturing occupations or occupations concerned with production technology – occupations with a high substitution potential. Where, on the other hand, branches with occupations with low substitution potentials predominate, such as health and social services or the hotel and restaurant industry, the regional values are correspondingly low.

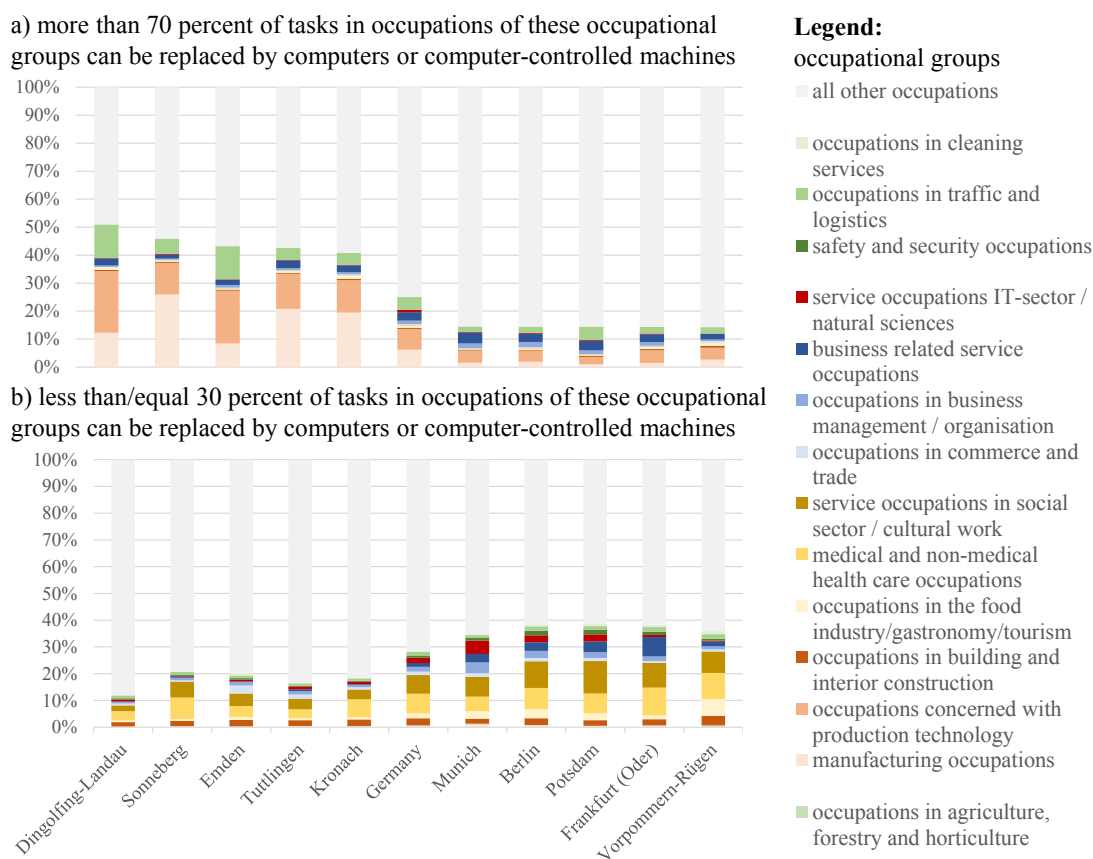


Figure 2: Districts with high and low shares of employees in highly (a) and low (b) substitutable occupations
Source: Dengler and Matthes (2018b), Statistics of the Federal Employment Agency (30 June 2017), Berufenet (2016).

Figure 2 illustrates the relationship between economic specialisation and substitution potentials by districts. It shows the occupational structure for the five districts with the highest number of employees and the five districts with the lowest number of employees in highly or low substitutable occupations as well as for Germany. The proportions of employees in the respective occupations are assigned to the corresponding occupational segments.

The five districts most affected – Kronach, Tuttlingen, Emden Stadt, Sonneberg, Dingolfing-Landau – reveal high proportions of employees working in the manufacturing occupations and occupations concerned with production technology. However, traffic and logistics occupations and business-related service occupations also play a major role here. Most other occupational segments contain comparatively few or no occupations in which more than 70 percent of tasks

could be replaced by computers or computer-controlled machines.

By contrast, in the five least affected districts – Vorpommern-Ruegen, Frankfurt (Oder), Potsdam, Berlin and Munich – many employees work in low substitutable service occupations. Occupations in which at most 30 percent of all tasks could be replaced by computers or computer-controlled machines are low substitutable. These are social and cultural service occupations and medical and non-medical health care occupations, as well as occupations in the food industry, gastronomy, and tourism in Vorpommern-Ruegen and service occupations in the IT sector and natural sciences in Munich. A number of occupations with low substitution potential can be assigned to business-related service occupations as well as to traffic and logistics occupations.¹

¹ Business-related service occupations as well as traffic and logistics occupations are the occupational segments in which there are relatively many employees in both low

substitutable occupations (e.g. specialists in dialogue marketing or specialists in advertising and marketing) and

3 VARIATION BY REGIONAL LABOUR MARKETS

To draw conclusions in a more comprehensive way, the focus should not only be on the results at the district level, but on those of regional labour markets within which one can expect compensating mechanisms. As can be seen in Figure 1, regions with low and high values are often close to each other. In order to take into account the extent to which the districts are linked to one another by employment flows, we consider the substitution potentials of regional labour markets. Compensating mechanisms can be expected within regional labour markets. If the digital transformation leads, for example, to an increase in the demand for highly qualified workers in a district, these workers can also be recruited from (neighbouring) districts within the same labour market. However, if the digital transformation leads to lay-offs of workers in a district, employment opportunities may arise in a neighbouring district of the same labour market. In regional labour markets that do not have a mixture of substitution potentials and predominantly consist of districts with a high proportion of highly or low substitutable occupations such compensating mechanisms are only possible to a very limited extent.

Figure 3 shows the proportion of employees working in a highly substitutable occupation by regional labour markets. The regions of Schwarzbach-Baar, Wunsiedel, Coburg and Siegen show the highest values with over a third of the employees in highly substitutable occupations, while Neubrandenburg, Rostock, Berlin and Greifswald/Stralsund show the lowest values with less than 20 per cent. Even though the aggregation of district values in regional labour markets has reduced the range of the values, there are regional labour markets, which are characterised by comparatively high values.

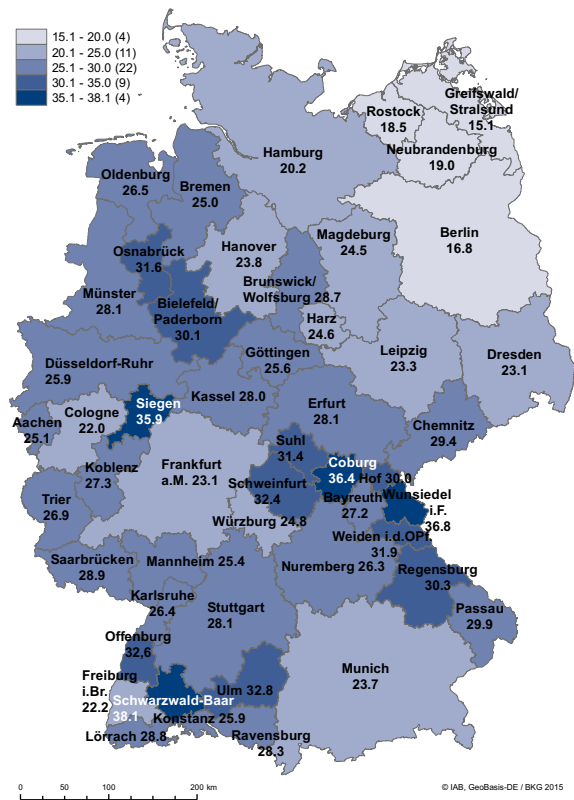


Figure 3: Share of employees working in highly substitutable occupations by regional labour markets

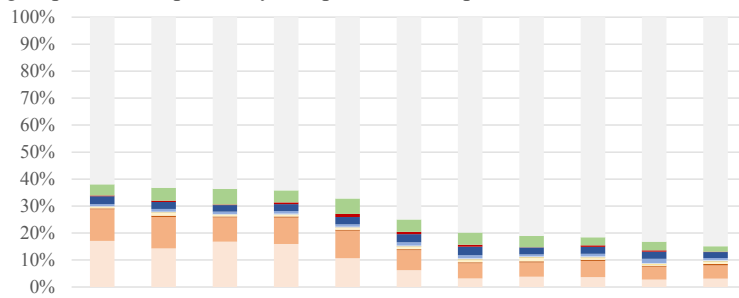
Source: Dengler and Matthes (2018b), Statistics of the Federal Employment Agency (30 June 2017), Berufenet (2016), Kropp and Schwengler (2016).

Similar to the districts, the share of employees in the manufacturing occupations and occupations concerned with production technology increases the regional substitution potential, while a high share of employees in the social and cultural service occupations or medical and non-medical health care occupations reduces it. Figure 4 analyses the occupational structure of low and high value regions. The occupational structure of regions with high and low values is very similar to figure 2.

Even if the employment shares in highly substitutable occupations do not differ as much between regional labour markets as between districts, the values in regional labour markets with high shares of employees in highly substitutable occupations are approximately twice as high as in regional labour markets with low shares of

highly substitutable occupations (e.g. bank clerks (skilled workers) and specialists in accounting).

a) more than 70 percent of tasks in occupations of these occupational groups can be replaced by computers or computer-controlled machines



b) less than/equal 30 percent of tasks in occupations of these occupational groups can be replaced by computers or computer-controlled machines

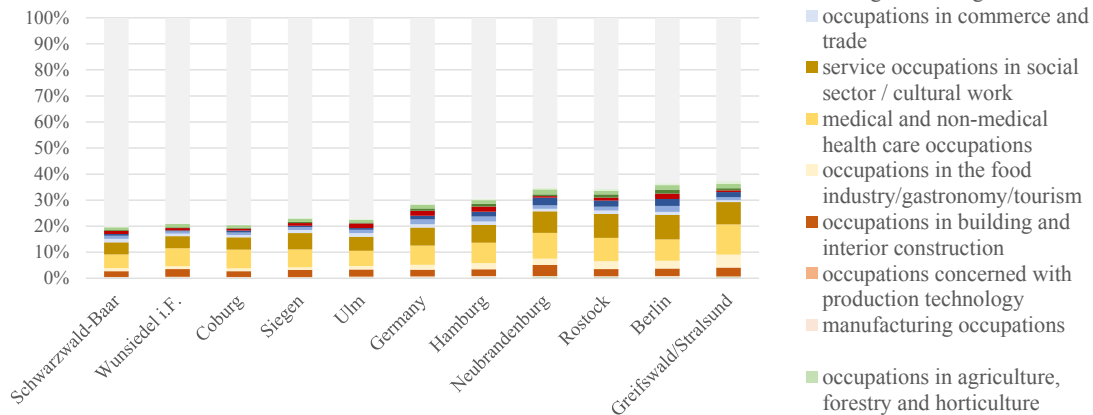


Figure 4: Regional labour markets with high and low shares of employees in highly (a) and low (b) substitutable occupations

Source: Dengler and Matthes (2018b), Statistics of the Federal Employment Agency (30 June 2017), Berufenet (2016).

employees working in a highly substitutable occupation. High substitution potentials may lead to greater changes in the occupational structure, either because occupations and their occupational profiles will change or because some occupations will shrink in number and others will grow, then labour market policy support and qualification offers are especially important in regional labour markets with high values.

4 CONCLUSION

The present study has shown how the occupational structure contributes significantly to regional differences in the share of highly substitutable occupations. The values for the districts in Germany ranged from 14 to 51 percent. The occupational structure in turn depends on the structure of the industry (Buch et al., 2016; Dengler et al., 2018). In particular, high shares of employees in the manufacturing industry lead

to high proportions of employees in highly substitutable occupations, while high proportions of employees in most service sectors significantly reduce them.

In many cases, low and high values cancel each other out within regional labour markets. Nevertheless, the share of employees in highly substitutable occupations still ranges from 15 to 38 percent. In the high value regions, labour market monitoring of future developments and further education appear to be of particular importance to meet the challenges of the digital transformation, because in these regions compensating mechanisms between regions with high and low substitution potentials are not to be expected. However, we do not assume that occupations with high substitution potentials may disappear or jobs get lost in regions with high shares of employees working in highly substitutable occupations. Substitution potentials consider only the technical feasibility. Whether these tasks are

actually taken over by computers will also depend on other factors such as legal and ethical obstacles, cost considerations and preferences (Dengler and Matthes, 2018a).

Projections up to 2035 show that 1.5 million jobs will be lost because of ongoing digital transformation, but at the same time the same number of new jobs will be created (Zika et al., 2018). This means that the challenge of the digital transformation lies less in the number of job losses rather than in the rapidly changing industry and occupational structure. Occupations will rarely disappear, they may adapt to new circumstances. Thus, the most important future challenge in the course of digital transformation is (further) education (Dengler and Matthes, 2015a).

Focusing on substitution potentials in occupations is in a way simplifying the reality of technological change. This view may underestimate the speed of adoption of new technologies in enterprises (Arntz et al., 2018) and it may overestimate the share of automatable jobs by neglecting the substantial heterogeneity of tasks within occupations as well as the adaptability of jobs in the digital transformation (Arntz et. al. 2017; Pfeiffer 2018). Nevertheless, we assume that occupations with high substitution potentials will change more due to the digital transformation than jobs with low substitution potentials, and regions with high values of employees in highly substitutable occupations experience also more change than regions with low values. This focus might help to guide further research about how vocational education and further education can facilitate the occupational mobility necessary to adopt to structural changes of the labour market.

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